this fixes itself on the stems or leaves of some water plant and there becomes encysted. In this condition the larvæ are swallowed by the grazing sheep.

The life-history of a typical trematode may then be summed up as follows:

1st. The egg produced sexually.
2d. The *ciliated embryo.*
3d. The *sporo-cyst,* produced asexually.
4th. The *redia,* produced asexually.
5th. The *cercaria,* produced asexually.
6th. The *adult trematode* (Leuckart).

MacGregor, acting on the supposition that the larvæ must have been taken in on some article of food peculiar to the Chinese, examined some specimens of the bêche de mer, a favorite article of diet among the Chinese, and found in them forms corresponding to both the sporo-cysts and the cercaria.

This, then, is a probable explanation of the method of introduction of the larvæ into the human subject.

The accompanying illustration, prepared with great care by my assistant, Mr. Washburn, affords a good representation of the internal structure of this organism.

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# AN INVESTIGATION INTO THE ETIOLOGY OF PHTHISIS.

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and

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## IV.

## On the Etiology and Local Treatment of Phthisis Pulmonalis.

By E. L. Shurly, M.D.

Following the trend of modern writings and expressions the whole subject of the etiology of phthisis pulmonalis and tuberculosis might be summed up by the statement, that these forms of disease are specific, with a specific cause, viz., the bacillus tuberculosis; every other factor being thus either swallowed up or playing a merely subsidiary part. And so dogmatic, not to say extravagant, are these numerous promulgations, that the professional mind generally has been led into this belief as a fact, that the existence of this microörganism really comprises the whole subject of the etiology of such disease conditions. Be this so or not, it does not seem to fit into the daily clinical observations which a careful comparative study of cases might display. If the observations put forth in a previous paper be at all correct we are forced then to assume that these complex conditions of disease, commonly entitled phthisis pulmonalis, or tuberculosis, differ from each other enough to be considered entities, and cannot be justly grouped together, either clinically or etiologically upon the bacillary theory *alone.* For, there *must* be something else in operation with the bacillus, either previously or subsequently, to produce the varying features. Although the predisposing causes of phthisis pulmonalis and tuberculosis are often, according to ordinary observation, alike, or nearly so; yet, it does not follow that these conditions *are the same,* either pathologically or clinically, any more than that Bright's disease and diabetes, or rheumatic arthritis (when following similar predisponants) are the same disease.

To avoid prolixity we shall not take up the whole range of predisposing and exciting causes abounding in medical literature, but confine our discussion to heredity, contagion, and environment principally, giving an outline only of our therapeutic experiments.

Concerning the importance of "heredity," or "hereditary tendency," as an etiological factor, there seems to be more or less difference of opinion; for, while many seem to believe that its origin and spread are due to a microörganism (bacillus), and its diffusion in the several ways incident to human intercommunication, the more conservative still lay great stress upon the idea of inheritance. All, however, admit that inasmuch as we are all being constantly invaded, so to speak, by the bacillus, that some peculiar condition of the body (immunity) exists to save the majority, while some opposite condition of the body (tendency) exists in the minority to determine the selection.

Of course, the subject of immunity (both acquired and natural) has engaged the thought of the profession for many years, and yet no scientific explanation has been adduced. Likewise the laws and principles of heredity have as yet baffled discovery. Intangible, like the forces chemical affinity and electricity, we know them by their effects only; but, unfortunately, heredity, unlike the former forces, does not operate in the same manner under the same conditions (so far as we are able to judge), and we are, therefore, unable to grasp its results. This will be one of the objects of our investigation when we can succeed (as we hope to) in breeding the higher monkeys in this country. While, therefore, this lack of absolute knowledge regarding the transmission of psychical and physical traits may account for some of the discrepancy of opinion prevailing, yet we ought not to shut our eyes to the observations or the facts (disconnected though they be) concerning the transmission of disease tendencies in the human subject. This is especially true of tuberculosis, which, as we know, will show itself through many generations, particularly in the young, requiring but the shadow of an exciting cause to incite active disease.

But, on the other hand, such a direct transmission cannot be shown strictly to operate in causing phthisis pulmonalis, for, although some families seem to show a marked tendency toward the acquisition of all sorts of catarrhal diseases, still, we often observe that several, or even many, members of such a family will entirely escape the acquirement of phthisis pulmonalis, even under considerable provocation.

There has been much discussion upon the question as arising here, and also concerning its existence as a congenital affection. Dr. Schwer, upon statistics based upon 123 autopsies of children (from 1879 to 1883), concluded that phthisis pulmonalis, or rather "tuberculosis," was not congenital, and yet he found that of this number the liver was the seat of tuberculosis in 104, the lungs in 103, the intestine in 63, the meninges in 53, and the thyroid gland in 12. It is plain that these statistics ought not to apply to phthisis pulmonalis.

The New York Board of Health, in 1886, reported that of 8540 deaths of children under one year of age 761 were reported as tuberculosis. That tuberculosis is often congenital, regardless of climate, it seems cannot be doubted by anyone who has had much experience with the diseases of children in the large cities. But the inheritance of a direct tendency to phthisis pulmonalis is extremely problematical. Dr. Landouzy (*Medical Record*, June 17, 1886) believes that congenital tuberculosis from birth to two years of age is more frequent than supposed, often not otherwise localized than as a broncho-pneumonia. Dr. Didama, on the other hand, believes, from the absence of *tubercle* in the *fœtus*, that it is not inherited. He quotes from insurance statistics many cases of phthisis, where both parents were healthy. Just what the advocates of the *purely bacillary* theory mean by *hereditary tendency* is not plain, since no particular condition or group of features is given as indicative of it, so that we are led to ask with Ruhle, of Bonn, how, by heredity, is a tubercular nidus formed in the body? We are all constantly assailed, they say, by the microörganism, but those only fall a prey who are susceptible, by virtue of some previous disease as a nidus—such as catarrhal inflammation. From this point of view, then, it must be that immunity only is inherited. However, until a proper differentiation between tuberculosis and phthisis pulmonalis is fully established, this conflict of opinion will continue. Nevertheless, we believe it is safe to say, in the light of every-day observation, that tubercular disease *is* hereditary, and, therefore, develops for the most part in a particular class of persons or animals, while phthisis pulmonalis may occur in any person living in a northern climate, after the acquisition of catarrhal inflammation of the respiratory apparatus.

Concerning the questions of "Contagion," "Inoculation," and "Infection," there is still much difference of opinion in print, although it is often asserted "nowadays" that an inoculable disease is contagious or infectious. The theory of contagion is an old belief. It was promulgated by Hippocrates and Galen. In Italy, in the middle ages, the law prescribed isolation of "consumptives." This was afterward repealed. The theory of contagion was again revived by Villemin (1865), and Klebs (1877), who found bacteria in sputum. In 1879, Musgrave Clay gave the histories of 111 cases said to have occurred by contagion. Potain, Guérin, Bernard, and others later, have given examples of similar character. In 1884, I believe, the Austrian Minister of the Interior ordered the isolation of "consumptive" patients. Cases of tubercular infection by sexual intercourse have been reported by Fernet in 1885 as examples of contagion. In this connection the experiments of M. Giboux (and repeated by other observers with varying results) are interesting. He caused one set of rabbits to inhale the air expired from phthisical patients, after it had passed through cotton-wool. At the same time he caused another lot of rabbits to inhale the expired air directly from the patients. The former lot of animals did not in any instance contract the disease, while of the latter lot each contracted it.

Dr. C. T. Williams, at the session of the British Association, 1882, from his experience at the Brompton Hospital for Consumptives, denied the spread of phthisis pulmonalis by contagion and infection. Sternberg, in 1882, and others since, failed to produce the disease in rabbits by inoculation, they even failed in some instances to find the bacillus tuberculosis. This result coincides with Dr. Gibbes's observations regarding the absence of the bacillus. Dr. Lynch, of Maryland, from a series of experiments, believes that the bacillus tuberculosis is *not* an essential factor in the production of phthisis pulmonalis. Dr. N. S. Davis, before the American Medical Association, in 1885, called attention to the *chemical facts* connected with the etiology of this disease, and questioned whether the bacillus alone was the cause of phthisis pulmonum. It has been claimed and at the same time been denied that in some animals tuberculosis or phthisis pulmonalis could be produced by inoculation with indifferent substances. Villemin, Cohnheim, Waldenburg, Burdon-Sanderson, Gutten, M. Martin, Wilson Fox, and others, have reported the production of the disease by such inoculations. But subsequent experiments by Dawson Williams were held by Wilson Fox to have disproved this.

Dr. E. L. Trudeau, in 1885, gave the results of the inoculation of rabbits with non-bacillary sputum, in which the disease, "tuberculosis," was not transmitted, as did also Dr. P. Gutten. Prof. S. Sterena, and Dr. B. Pernice, after a series of experiments upon lower animals, concluded that the liquid, after evaporation, of the sputum of phthisical patients is constantly free from bacteria, and when injected into the cornea or peritoneal cavity produces neither local nor general tuberculosis.

That phthisis-producing bacteria are not found in the surrounding atmosphere as a result of evaporating tuberculous sputum, although such organisms may be abundant therein. That respiration for several days in a close atmosphere containing tubercular sputum does not produce tuberculosis in such animals. That animals confined in close quarters and compelled to breathe an atmosphere laden with the dust of dried tubercular sputum do not contract "tuberculosis." That subcutaneous injection of tuberculous matter produces mostly local specific manifestations, as shown by the presence of bacilli in the pus from the lesion, and, after a time, produces "tuberculosis" of the abdominal or thoracic organs or "general tuberculosis." That injection in a trachea, even with a bronchial catarrh, does not cause a specific infection, but a septic croupous pneumonitis.

Again as to the question of contagion, the investigation reported by Dr. Vallien at the meeting of the Société Médicale de Hôpitaux, showing the great diversity of opinion among medical men, is interesting. He sent a list of questions to 10,000 medical men, from whom 123 answers were received. Of these, 57 believed in its contagiousness; 57 disbelieved in it; 7 doubted, and in 2 the answers were incomprehensible. Of 439 cases reported, 213 supported the hypothesis of contagion, and 226 were against it. Of the former, 107 were cases of contagion between husbands and wives; 71 near relatives; 18 were offspring of phthisical parents, and 16 were contracted from distant relatives. There are a number of cases reported of inoculation of the human subject with tuberculous matter or sputum, as for instance the case reported by Elscherung, in 1883, of a young woman who accidentally inoculated her hand while cleaning a cuspidore containing the sputum from a phthisical patient. It has been reported that the phthisis pulmonalis or "tuberculosis" has been known to have been communicated through the agency of flies.

Much more of this sort of literature could be quoted—all more or less conflicting. But enough, we think, has been presented to illustrate that probably much of this confusion of deduction arises from an improper discrimination, at times, between phthisis pulmonalis and tuberculosis.

Our experiments, as far as we have gone, seem to show that the exposure of a *healthy monkey* to the inhalation of *dried sputum* containing the bacillus tuberculosis of Koch, by means of frequent insufflations, *will produce* phthisis pulmonalis. The insufflations must be kept up, however, several times daily, for a period of about six weeks, to accomplish it. Both Dr. Gibbes and myself have also produced so-called tuberculosis in guinea-pigs by the inhalation and inoculation of indifferent substances. We have not tried this on monkeys. To test somewhat the force of contagion we have placed, in restricted quarters, *healthy* with so-called *tuberculous* monkeys without effect. The same thing has been done with guinea-pigs, as stated by Dr. Gibbes in a former paper, with the same negative result. In the "phthisis wards" of Harper Hospital we have never been able to discover any effects due to contagion, although our microscopist, Dr. Duffield, has found bacilli tuberculosis in the air. Following the experiments of Dr. Vallien, of Paris, we have treated sputum containing bacilli with chlorine gas and sulphuretted hydrogen and then inoculated guinea-pigs with it; at the same time inoculating other guinea-pigs with some of the same sputum which had not been exposed to either of these gases, with equally fatal results, excepting the more rapid course of the disease in the latter animals. The spread of phthisis pulmonalis by the consumption of cow's milk is just now attracting considerable attention. At the recent congress of Physicians and Veterinary Physicians, held at Paris, for the discussion of the subject of "tuberculosis," many papers upon this subject were presented, varying more or less according to individual observation. The majority, however, seemed favorable to the view that cow's milk (*i. e.*, tuberculous cows) was in great part responsible for the spread of phthisis pulmonalis. We have made no experiments as yet in this direction, but expect soon to begin some by feeding monkeys principally with milk obtained from diseased cows.

It would appear, however, from observation in this country, where the consumption of cow's milk is very great, that most of the views expressed were far too radical! Whether or not so-called tuberculosis is transmitted from mother to infant through the milk, is for obvious reasons very difficult to determine. We do not, however, agree with Prof. Edouard Rengi, who states from the basis of six experiments, that mothers do not directly communicate this virus (tubercle) to children through suckling, because both Dr. Gibbes and myself have each notes of two cases of "tabes mesenterica" which undoubtedly originated in this way. My cases were those of previously healthy infants, of healthy parents, and good family history, and were suckled by *tuberculous* or rather *scrofulous* wet-nurses!

The part played by environment and its attending circumstances in the causation of phthisis pulmonalis has received considerable attention heretofore, and it will not be necessary more than to allude to it now. The accumulated experience of years points, without doubt, to the very great influence of unsalubrious habitat and occupation, together with scarcity of, or improper food, in the production of such disorders. Dr. Porter, of the Madras Medical College, reports in the *Indian Medical Gazette*, that during the famine there in 1888, in 459 consecutive autopsies, made during that time, "tubercular deposits" were found in one or both lungs in 30 men (6½ per cent.), and in 20 women (4¼ per cent.), and 1 child. The deposits were partially in both lungs in 18 men and 16 women. The disease was latent in 18 men and 13 women.

Dr. Bowditch and others have shown by statistics the prevalence of phthisis pulmonalis in low, shady, damp places, while there is already abundant proof of the deleterious effects of unhealthy occupations and crowded institutions or workshops. These latter conditions of life are frequently cited as constituting the principal etiological factor. The experiments of Trudeau are quite illustrative of the point. He inoculated ten rabbits; five of them were allowed full liberty and good food, while the other five were confined. The five allowed to run were not diseased at the end of four months, while the others were. We have not as yet completed our experiments on this line; but, as far as we have gone, have found that unsalubrious surroundings or improper feeding will surely predispose the animal to attacks of catarrhal inflammation which lead eventually to phthisis pulmonalis. According to some authorities, such conditions of life are quite sufficient to bring about so-called tuberculosis in every instance. Others maintain, on the other hand, that such vicissitudes are but coincident or exciting causes and that a *tuberculous focus* in the body *somewhere* must have existed previously, which, under these untoward circumstances, is "lighted up." However this may be, it seems clear that the real trouble lies in an imperfect differentiation between tuberculosis and phthisis pulmonalis. Review, if you please, the mass of literature relating to the so-called surgical tuberculosis; tuberculous joints; tuberculous ulcerations of the skull, ribs, or long bones, and note how at variance with prevailing notions of pathology and clinical observation many of these statements are. We are now engaged in conducting some experiments on guinea-pigs, by inoculations of and exposure to material from so-called tuberculous joints, which thus far do not exactly coincide with modern ideas of so-called surgical tuberculosis.

Our experiments of a therapeutical character are far from completed. We are still conducting a series of experiments upon monkeys and human beings (mostly local measures), at Harper Hospital, Detroit, where we have arranged suitable inhaling rooms and other necessary apparatus, and a room for monkeys and guinea-pigs so arranged as to facilitate the handling and sequestration of these animals for our purposes. For the use of gases on the animals, we have a gas cage capable of being almost, if not quite, hermetically sealed, provided with ground stop-cocks for the ingress and egress of air or gas in any desired quantity. For the use of agents in the form of sprays, the cages are provided with shunting partitions, both perpendicularly and horizontally, and a heavy canvas flap for the front, so that we can confine an animal to a very small space if desired, and thus thoroughly expose it to the medicament. We have used thus far, sulphuretted hydrogen, chlorine gas, arseniuretted hydrogen, iodinized air, iodoform (by mechanical insufflation), chlorine water, calcium hypophosphites in solution, carbolic acid, creolin, naphthalin, creasote, mercury bichloride, mercury biniodide, mercury cyanide, eucalyptol, turpentine, and thymol. While we have gained some knowledge from our work in this direction, it must be confessed that we have only just been introduced, as it were, to the vast field of knowledge yet to be attained.

We have made some attempts, also, to medicate monkeys by the mouth, which is very difficult, and in this connection we have to acknowledge our great indebtedness to our two assistants, Messrs. Thaddeus C. Walker and Robert Walker, for their pluck and zeal in carrying out faithfully our ideas and plans. Our experiments with sulphuretted hydrogen have shown that even in a diluted form it is highly poisonous; monkeys exposed to it while incarcerated in the gas cage, very soon and suddenly lose consciousness, falling (as if struck on the head) in convulsion. That this phenomenon occurs without any premonition is proved by the accidental experience of Mr. R. Walker, who, through an accident to the apparatus, suddenly became exposed to the gas for a very short time, and, without any feeling of premonition, dropped to the floor unconscious; the consequences of which would have been fatal but for the timely presence of Dr. Dumas, who dragged him to the open air. From my reading of medical literature I do not believe that the poisonous properties of this agent are sufficiently appreciated. Thus, some of the sudden deaths reported from the use of the "Bergeron method" of treatment, may be accounted for. May not this also account for some of the hitherto inexplicable sudden deaths reported, and vaguely attributed to other causes, such as Trousseau has alluded to? Neither Catani, Hugenschmidt, nor Nepse, who have actively advocated the use of sulphuretted hydrogen and sulphurous mineral waters by inhalation, have mentioned any particular danger of this sort. We have ascertained that this gas (sulphuretted hydrogen) is fatal to monkeys when inhaled in greater proportion, with air, than about one to five hundred for more than about three minutes.

A long series of experiments with chlorine gas as an inhalant has thus far yielded no satisfactory results. A great deal of time and labor has been expended in determining the maximum amount of gas (by volume, of course) that a monkey—either healthy or diseased—could respire, for any given length of time. We have finally ascertained that a good-sized healthy Rhesus monkey will stand the inhalation of chlorine gas mixed with air in the proportion of 1 : 3500, for about ten minutes at a time. Those suffering with phthisis pulmonalis do not bear this quantity. Exposure to the atomization of chlorine water is endured more easily, and for a greater length of time. This treatment applied to a man suffering with advanced phthisis pulmonalis caused great distress to respiration, followed by excessive expectoration.

The consequence of the use of too much chlorine, as observed in monkeys, is increased respiration and excessive cough, vomiting, lachrymation and coryza, and if continued too long, slight convulsions. No effect upon the course of the disease has as yet been noted, except in a few instances the production of increased bronchial catarrh was sure to follow.

Iodoform, which has been so highly written and spoken of for its efficacy in so-called tubercular affections, has been used by us persistently (by means of insufflation, combined in varying proportions with starch or magnesium carbonate) in several inoculated monkeys, as also upon the human subject. In the human cases no benefit could be observed. Of the monkey cases, two were observed to have been benefited, but not saved. We observed, however, that the monkeys treated by it all showed marked evidence of fatty degeneration of the liver.

Arseniuretted hydrogen was used in one instance only. It was pumped —mixed with air—into the gas cage. It effects were so baneful—causing great distress, nausea, vomiting, and diarrhœa—that it was abandoned. This agent is so dangerous to all animal life that further experiment with it will be postponed until we can obtain safer facilities for its manufacture and manipulation.

Mercury bichloride has been used by inhalation quite extensively, both upon monkeys and in the wards of Harper Hospital, with very promising results. With those cases possessing a syphilitic taint this agent has proved quite efficacious. We use from one-half to one or two ounces of a solution 1 : 3000, for each inhalation in the form of spray.

Mercury biniodide has also given good results when used as an inhalation, in the same proportion as the bichloride, especially in cases of laryngeal phthisis in the early stages. In two or three cases its constitutional effects (diarrhœa and epigastric distress) were observed.

Creasote has shown no particularly good effects, except in destroying the fetid odor arising from a certain class of cases. Neither has turpentine, either alone or in combination with thymol or eucalyptus, proved efficacious, except in cases of simple bronchial catarrh. The same may be said of either eucalyptus or thymol when used alone.

Carbolic acid used as spray, incorporated with petroleum oil, has seemed beneficial in the subacute and chronic forms of phthisis pulmonalis; but, on account of the difficulty of keeping it constantly and thoroughly suspended, it has been abandoned for creolin, which is, from present indications, far superior in its effects and more easily adapted to inhaling purposes.

Hypophosphite of calcium is showing itself to be of decided benefit in the local treatment of the chronic forms of phthisis pulmonum. We are in hopes of being able to report excellent results from it in the future.

The plan of extra-alimentation by forced feeding has not as yet received much of our attention. We hope, however, to try it with some inoculated monkeys. We are still experimenting with these and other agents, by their local use, and as soon as possible intend to test more thoroughly the qualities and effects of calcium sulphide, salicylic acid, boracic acid, etc., both locally and by internal administration.

# A CASE IN WHICH CEREBRAL LOCALIZATION WAS ILLUSTRATED BY THE EFFECT OF MENTAL IMPRESSION.

By Andrew H. Smith, M.D.,

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Mr. I. consulted me about three years ago for a condition of the right wrist and hand, from which he had suffered for several years, and which resembled writer's cramp, but differed from that affection etiologically, and in that the condition was one of tremor rather than of spasm. It was not the result of any special or excessive use of the hand, and was associated with a slight degree of paresis of the right leg.

There was a good deal of occipital pain, which I found to be dependent upon defective action of the ocular muscles. This was completely relieved by prisms selected by Dr. Noyes. Singularly, not only was the pain relieved by the use of the glasses, but the condition of the hand and leg was considerably improved.

As a great variety of treatment had been tried before I saw the patient, and he had suffered much of many physicians, specialists included, I now advised him to rest content with the measure of relief he had obtained, and to desist from further treatment, diverting his mind as much as possible from his condition by active employment.

Pursuing this course he has gotten on in the main very well up to the present time. His general health has improved, and the hand and leg are decidedly better. He is, however, still obliged to write with his left hand, although the right is fairly useful for other purposes.

This was his condition when, a few days ago, he became interested in reading the article in *Harper's Magazine* for May, in which Mr. Chittenden describes his experience in signing, as Register of the Treasury, 12,500 United States bonds in sixty-four hours, and the physical distress which the effort occasioned. As he progressed in the reading Mr. I. experienced a severe pain, beginning in the right hand, running up the arm into the neck, then into the occiput, and at last settling with great intensity in a circumscribed spot on the left side of the head. In describing this pain to me he indicated with his finger as accurately as I